

fifteen years of a precarious life, he at last sank under another attack.

PROCEEDINGS OF VARIOUS OBSERVATORIES.

Royal Observatory, Greenwich.

The work at the Royal Observatory since the date of the last Report has been of the same character as in previous years, the Moon being considered still the most important subject of observation.

During the past year the usual meridional observations of the Sun, Moon, and Planets, have been made with the Transit Circle, whilst the Moon has been observed with the altazimuth on every available opportunity, together with a high star and the collimator for the determination of the instrumental errors.

For the last four months the observations of the small planets have been continued all through the lunation, instead of merely in the first half, as it appeared probable that no observations would be made in Paris during the continuance of the siege. This has necessarily pressed rather heavily on the observers, though no serious inconvenience has been experienced in consequence, notwithstanding the absence of Mr. Carpenter on Dr. Huggins' Oran Expedition.

Two satisfactory series of observations of the Solar Eclipse have been made with the great equatoreal and with the altazimuth respectively, the reduction of which has thrown a large amount of extra labour on the computing staff of the Observatory, though the usual reductions have proceeded without interruption. Although dense clouds obscured the Sun in the early part of the eclipse, numerous measures of the differences of R. A. and N.P.D. of the limbs of the Sun and Moon and of the differences of N. P. D. of the cusps were taken with the former instrument during the progress of the eclipse, in accordance with a carefully-arranged plan of observation. From these the corrections to the tabular differences of R. A. and N. P. D., and to the semi-diameters of the Sun and Moon (the latter, of course, affected with twice the amount of irradiation) have been deduced with great accuracy. The errors of Hansen's Tables appear from these observations to be sensibly the same near conjunction as in other parts of the Moon's orbit.

With the altazimuth three sets of double azimuths of the Moon's second limb and six of the first limb, together with three pairs of zenith distances of the upper limb were taken while the Moon was on the Sun's face, giving the diameter in azimuth as well as the tabular error in Right Ascension and North Polar Distance. This determination of the diameter, combined with measures of the azimuthal diameter of the bright Moon previously taken, will, it is expected, give data for obtaining the amount of solar or lunar irradiation in this instrument.

The proposed observations with the Transit Circle were lost through cloud at the time of transit, which is the more to be regretted as but few observations of the Sun are available to determine the correction to his tabular place about the time of the eclipse, which is required in the differential observations with the great equatoreal in order to deduce the error of the lunar tables.

From the same cause the first contact was lost; the times of last contact observed with various telescopes show the usual discordances due to difference of instrumental power.

The new water-telescope, for the determination of the effect on the co-efficient of aberration (as given by observations of γ *Draconis*) of the passage of the rays of light through a column of water, has been brought into working order, after some trouble experienced in securing the freedom from constraint of the object-glass, which is in contact with the upper surface of the water. A succession of cloudy days for some time prevented any regular observations with the instrument, whilst the risk of frost on the approach of winter soon rendered the removal of the water necessary until the weather should become more settled. Practically, however, the observations will be confined to those seasons of the year when γ *Draconis* passes the meridian about 6 A.M. and 6 P.M., at which time the greatest effects due to the aberration are observed. The observations will, therefore, shortly be resumed.

Ever since the erection of the transit-circle a gradual subsidence of the eastern support has been noticed, necessitating the application of a rather large correction for level. In order to remedy this inconvenience, as no adjustment of the Y is provided, about a ton weight of stone was placed on the western pier, but without producing the slightest appreciable effect—a good proof of the great stability of this instrument. As the western support could not be lowered, the plan was adopted of raising the eastern, for which purpose the Y was raised from its bed, and a sheet of thin paper, $\frac{1}{2}\frac{1}{70}$ -inch in thickness, placed under it, after which the level error was found to have been reduced by the quantity required, viz. 10", whilst by means of the collimators the Y was replaced without sensibly affecting the azimuthal error.

The New Seven Year Catalogue of Stars observed with the transit circle from 1861, Jan. 1, to 1867, Dec. 31—all reduced to the epoch 1864, Jan. 1—has been printed and distributed, as well as the volume of *Greenwich Observations* for the year 1868.

Independently of its intrinsic value, as affording standard points of reference for differential observations, it is hoped that this Catalogue will prove of great value to astronomers, as giving reliable data for determining the proper motions of *all* the stars observed by Bradley, and given in Bessel's *Fundamenta Astronomiæ*, many of which have not been included in previous catalogues.

The printing of the Astronomical portion of the Volume for 1869 has been proceeding more rapidly than usual, and is now,

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with the exception of some few sections, quite finished, whilst the reductions of the observations are nearly complete to the end of the year 1870.

In August last the Observatory lost the able services of Mr. Stone, on his appointment by the Admiralty to the important office of Astronomer at the Cape of Good Hope, on the resignation of Sir Thomas Maclear. He has been succeeded as chief assistant by Mr. W. H. M. Christie, B.A., of Trinity College, Cambridge.

Cambridge Observatory.

The transit instrument was dismounted in the course of the year 1869, and preparations were made for the mounting of the transit circle in the place of it.

Unexpected difficulties which Mr. Simms met with, however, in constructing the new instrument, long delayed its completion, so that it was not ready till October 1870. Mr. Simms completed the mounting of it in December; and the first assistant, Mr. Graham, is now engaged in the determination of wire intervals and other elements of reduction, and in the examination of the circle and pivots.

Prof. Adams believes that this instrument, for which the Observatory is indebted to the munificence of Miss Sheepshanks, will prove to be one of the finest of its class. The object-glass of the telescope is an excellent one, by Cooke, of 8 inches aperture. There are two divided circles of 3 feet in diameter, one of them being fixed relatively to the axis of the telescope, and the other moveable and capable of being clamped to the axis in any position. Each of the divided circles is read off by means of four micrometer microscopes, and additional microscopes, if required, may be readily applied. There are two collimating telescopes, each of 6 inches aperture, which can be directed upon each other through an opening in the central cube. A powerful apparatus is likewise provided by which the instrument may be readily and safely reversed. There are no screw adjustments for azimuth and level, but the axis of the instrument is brought into its definitive position by scraping the Y supports.

The meridian observations having been necessarily interrupted, the work done in the Observatory during the past year has been chiefly confined to the reduction of the observations and to the preparation for the press.

The Transit and Circle Observations for several years are now arranged for the press, as well as all the Equatoreal Observations of Comets and Occultations.

The printing of the Observations has commenced, and having such a large mass of materials ready, Prof. Adams hopes that it will now proceed rapidly.

The meteorological observations have been made at the usual hours of 9 A.M. and 3 P.M.

Radcliffe Observatory, Oxford.

The Radcliffe Observatory has, in the past year, as in the one preceding, suffered by the death of a valuable assistant. Mr. Béchoux, whose appointment to the office of second assistant was notified in the last Annual Report of the Society, died suddenly on the 13th of August last, of heart disease. He had devoted himself so vigorously to astronomy, that his death may be considered as affecting its interests generally as well as the Radcliffe Observatory, which has felt his loss severely. It is, however, gratifying to be informed that the vacant situation has been ably filled by Mr. Gabriel Keating, formerly employed at Greenwich and well recommended by the Astronomer Royal, and that his services are likely to be valuable to the Observatory.

The work performed during the past year is of the same character and of about the same amount as in preceding years. The 27th volume of the *Radcliffe Observations* for 1867 was published and distributed in July last, and the printing of the Astronomical portion of the volume for 1868 is nearly completed. The Catalogue of Stars, in number 1772, included in this volume, has been printed, and several copies stitched up separately, for the convenience of astronomers, to whom it may be useful. The volume will contain also about the same amount of planetary and extra-meridional observations as the preceding.

With regard to the reductions, they are in nearly the same state of forwardness as usual. The transits are completed to the end of 1870, and the North Polar Distances nearly so to the end of 1869, the entries and first steps of reduction of the latter being kept up pretty nearly to the present time. The Catalogue of Stars for 1869 is complete as far as concerns the Right Ascensions; and it only requires the North Polar Distances, when ready, to be written into it, to make it absolutely complete. It will contain about 1400 stars.

The times of beginning and ending of the recent Solar Eclipse were observed,—the latter very satisfactorily; and it may be worth while to mention with regard to the Heliometer, that Mr. Simms has recently made for it a solar eye-piece with polarising prisms for diminishing the light at pleasure. Up to the present time this splendid instrument has not been furnished with any apparatus for observing the Sun conveniently.

Stonyhurst College Observatory.

Several improvements have been carried out in this Observatory during the past year. The arrival of the large Spectroscope constructed by Simms, on the model of the one previously made by him for Mr. Huggins, led to the complete fitting-up of the Spectroscopic Studio adjoining the Equatoreal room. The battery required for the metal spectra is kept in the ceiled cellars

beneath the Observatory, so that the instruments may not be injured by the acid fumes, but cells of bichromate of potash are always ready in the studio for any occasional experiment. The room is also provided with spectrum maps, induction coil, spark apparatus, vacuum tubes, &c.

The old pulleys and bevel gearing have been removed from the Equatoreal shutter to make way for a rack and pinion.

The Equatoreal has been employed chiefly in the measurement of double stars and of the solar spectrum lines, and in the study of the prominences. Positions of new comets have always been obtained when the weather was favourable, and a careful watch kept for the periodic meteors.

An $8\frac{3}{4}$ -inch Cassegrain mounted on a Tully altazimuth stand, and a 4-inch achromatic by Jones, were taken to Spain for the observation of the Solar Eclipse. The large Spectroscope was adapted to the Cassegrain, and the Jones Equatoreal was provided, in case of need, with a small Spectroscope, and a polarising eye-piece consisting of a Nicol and a quartz wedge.

In the Meteorological department the daily photographic records of the thermograph, barograph, and magnetographs, have been continued, as have also the curves for the velocity and direction of the wind. A new self-registering rain-gauge made by Hicks from Beckley's design has just been received from the Meteorological Committee. There has been no break of continuity in the series of daily meteorological observations and of monthly determinations of the magnetic elements. The results are as usual printed for private circulation.

A paper has been presented to the Royal Society on the reduction of a seven-years' series of magnetic observations at Stonyhurst, and the second part of the French Magnetic Survey is almost ready for publication.

Royal Observatory, Edinburgh.

During the past year the daily time services by electric ball, gun-fire, and controlled clocks, have been continued as usual. Also the more laborious, and equally obligatory, work of computing the bi-diurnal observations collected from each of fifty-five town and country stations of the Scottish Meteorological Society, and sending the chief results in certified forms to be printed by the Registrar General of Births, Deaths, &c., in Scotland at the end of every month and quarter; and they have been printed accordingly.

The long kept up weekly observations of the carefully planned and very accurate series of the Edinburgh Observatory rock-thermometers, have recently been reduced to one uniform plan from their commencement in 1837, down to the end of 1869; and in that shape have been communicated to the Royal Society of London. A discussion of certain supra-annual cycles of tem-

perature in the Earth's surface crust, thus arrived at, accompanied the MS. figures; together with a forecast founded upon them, of the temperature characteristics to be, of the present season;— the date of communication of that forecast having been the beginning of last March.

Excepting only a few instances, the usual meridian observations of stars for place, with the transit instrument and mural circle, have been discontinued for a time; partly, because there has been only one assistant in the Observatory during a large portion of the year; and partly, in order to allow of the computation of past observations in right ascension and north polar distance being more speedily overtaken.

A Report of 34 pages with several plates (intended to appear also in the 13th volume of the *Edinburgh Astronomical Observations* now commencing at the press), addressed to the Government Board of Visitors, has been printed by the Astronomer during the past summer, and generally circulated. It contains, amongst other Observatory topics, an inquiry into the fluctuations of the position of the transit instrument on the Calton Hill, during the last twenty-nine years, and traces them up, both astronomically and experimentally, at last, it is believed, to their true source, viz., the untoward *physical* nature, touching thermotic effects, of the particular kind of stone of which the said piers are constructed; and an inquiry is therefore now much desired to be commenced into the degrees of suitability of different materials for the most exacting of the astronomical requirements of a first-class Meridian Observatory.

Glasgow Observatory.

The operations at the Glasgow Observatory continue as heretofore to be devoted chiefly to a course of star-observations, the objects selected for this purpose generally ranging between the sixth and ninth magnitudes. Some observations of the minor planets have also been made with the transit-circle during the past year, and the results are now being prepared for publication in the *Astronomische Nachrichten*.

Greenwich Mean Time has been transmitted electrically as in past years to the City and Port of Glasgow. Increased facilities have recently been given for the rating of chronometers, and the admirable advantages of Jones's invention are now appreciated by all classes of the community.

Since the beginning of the year 1868 a system of meteorological observations executed with self-registering instruments has been in operation at the Glasgow Observatory. The observations are conducted at the public expense under the superintendence of the Meteorological Committee of the Royal Society. The results of the observations are transmitted weekly to Kew, whence they are forwarded to the Central Office of the Committee in London. During the past year a Quarterly Weather Report has been pub-

lished under the superintendence of the Committee, including, among other matters of interest, a graphical delineation of the results obtained with the various self-recording instruments at the even affiliated observatories.

Kew Observatory.

The Photoheliograph has been worked under the direction of Mr. De La Rue during the past year, the ninth of the continuous photographic observations of the Sun. From Jan. 1 to Dec. 31, 1870, 380 pictures were obtained on 220 days. During the eclipse of Dec. 22 only five pictures could be made in consequence of the unfavourable state of the weather; the heliographic positions of the Sun-spots for that day have been determined from some of the Sun pictures, and will be communicated to the Society. By means of a grant of money made by the Royal Society for that object, six sets of positive prints have been struck off for distribution from the whole series of negatives obtained during the nine years the heliograph has been at work, and completed up to date. In 1869 Messrs. De La Rue, Stewart, and Loewy presented a paper to the Royal Society (*Phil. Trans.* vol. clix. p. 1), containing a full description of the method adopted by them for ascertaining the position and areas of Sun-spots, and tables giving the areas and positions for the various Sun-spots observed during the years 1862-3 at Kew. A paper read before the Royal Society on March 10, 1870, and just published, contains the same elements for 1864-5-6; it also contains a discussion of Hofrath Schwabe's (of Dessau) collection of drawings of the solar disk from the time of their commencement in 1825 to that of their termination in 1867. The Kew heliograph will be worked until December 1871 by means of a sum voted from the Government grant of the Royal Society, when, unless some steps are taken to carry on the observations, systematic Sun-work will be discontinued in England.

Mr. Huggins' Observatory.

During the past year the Observatory has been rebuilt, and a drum of 18 feet diameter erected in place of the former dome of 12 feet diameter, to fit it to receive the large equatorial instrument constructed by Messrs. Grubb and Son for the Royal Society, and by that Society placed in the hands of Mr. Huggins.

This instrument is provided with a tube and object-glass 15 inches in diameter, and a tube fitted with a speculum of 18 inches diameter, either of which can be attached at pleasure to the declination axis of the equatorial mounting. The focal length of the object-glass, the lenses of which are united with castor-oil, is 15 feet. This instrument performs admirably in all respects and does great credit to the makers.

Spectroscopes specially adapted for the instrument and suitable

for the observation of the stars, nebulae, and Sun, have been constructed by Messrs. Grubb and Son on the very admirable plan of automatic motion for minimum deviation recently described by them in the *Monthly Notices*.

There has not been time, as yet, to do more than make the preliminary observations for the adjustments of the instrument.

NOTES ON SOME POINTS CONNECTED WITH THE PROGRESS OF ASTRONOMY DURING THE PAST YEAR.

General Remarks.

The progress of Astronomy, in common with that of every other science, has been affected by the terrible war, which has so largely absorbed the attention of all classes since July, 1870. We have been influenced by it in England, but in France and Germany scientific progress has been greatly interrupted. Even before the completion, in September last, of the great cordon of troops and artillery which shut off Paris from the rest of the world, the effects of war on science were shown by the reduced size of the *Comptes Rendus*, and the disappearance of some French scientific journals. In Germany, many young astronomers of great promise, not altogether unknown in this country, exchanged the observatory for the battle-field, where some, alas! have fallen.

But notwithstanding these unfavourable circumstances, the year just closed has not been barren of discoveries. Three planets, hitherto unrecognised, have been added to the known members of the solar system; four comets have been detected, some even in Germany by an observer at no great distance from the scene of war; and an increase of our knowledge of the constitution of the Sun has been undoubtedly obtained from the recent Solar Eclipse, to observe which, two of the greatest astronomical expeditions of modern times were organised and despatched from this country and America to Sicily, Cadiz, Gibraltar, and Oran. In our own Society the evening meetings have been well attended, at which important papers—of which a list will be found on another page—have been read and freely discussed.

The Total Solar Eclipse, Dec. 22, 1870.

As this eclipse would be total at several places within easy reach of England, namely, the south of Spain, Sicily, and the north coast of Africa, it appeared to the Council an occasion on which they should take steps to assist observers, and, if necessary, organise an expedition provided with suitable instruments for attacking the important problem which still remained unsolved,